

LAND SHELLS OF THE GENUS *BULIMULUS* IN LOWER CALIFORNIA, WITH DESCRIPTIONS OF SEVERAL NEW SPECIES.

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(With Plates LXXI and LXXII.)

The peninsula of Lower California is known as the home of several interesting species of the genus *Bulimulus*, including what is, perhaps, the largest species of the genus, *B. montezuma*. As much of the peninsula, in its arid highlands, recalls the analogous districts of Peru and Chile, so the land shells, especially the *Bulimuli*, bear in their external characters the imprint of a similar environment, which has gone so far that, in one or two cases, the similar species of California and Peru have been referred to the same species. An examination of a good series shows, though this opinion proves to be mistaken, that there was reasonable ground for it in the remarkably similar effects produced by the similar environment acting upon plastic forms of the same genetic history, in the two widely separated regions. The reception of an interesting series of specimens from the California Academy of Sciences, collected by an exploring expedition sent out by them, and the attempt to name them, and simultaneously to review the species already well represented in the national collection, gradually led to the study embodied in the present paper.

The first species of the group from this region was described by Sowerby in 1833; others were named by Gould in the Boston Journal of Natural History in 1852-53. An account of most of the older species may be found in the "Land and Fresh-Water Shells of North America," Part I, by Binney and Bland, pp. 191-208, 1869. Later references to them appear in the great work by Crosse and Fischer on the land and fresh-water mollusks of Mexico, and in papers by Dr. J. G. Cooper in the proceedings of the California Academy of Sciences, second series, III, pp. 99-103, 207-217 and —, with Pls. XIII and XIV, and also in Zoe, Vol. III, p. 11, April, 1892. The figures on the plates above mentioned are, unfortunately, not as characteristic as might be wished. There is also a short paper by the writer on *B. proteus*, in the Nautilus, of July, 1893.

Genus **BULIMULUS** Leach.Section **SCUTALUS** Albers.**Bulimulus (Scutalus) pallidior** Shy. (*B. regetus* Gould.)

Normally arboreal; elevation 100–500 feet, chiefly in the southern part of the peninsula; San Jose del Cabo, Belding, Eisen; Cape St. Lucas, Xantus; Punta Arena, Bryant; Carmen Island, Stearns; Santa Margarita Island, U. S. Fish Commission; Costa Rica, Zeledon. (Plate LXXII, Figs. 2, 3.)

There is the typical form, polished and without any visible spiral striation, which varies from acute and slender ( $20+40^{\text{mm}}$  and 7 whorls) to stout and short, with a larger umbilicus ( $28+45^{\text{mm}}$  and  $6\frac{1}{2}$  whorls). It also varies a good deal in size. The specimens from Costa Rica are rather thin and the lips rather widely expanded. They agree perfectly in other respects with the Lower Californian shells.

The spiral striation in many specimens becomes pronounced and in some reaches a point comparable to the surface of the *B. montezuma*. For this variety I have used the varietal name *striatulus*. It is particularly noticeable in collections from Carmen and Margarita islands and the Gulf coast of the peninsula.

**Bulimulus (Scutalus) montezuma** Dall. (*B. proteus* auct. non Broderip.)

Almost confined to the mountains of the peninsula at an elevation of 2,000 to 3,500 feet (Cooper). See the Nautilus, July, 1893, p. 26. (Plate LXXII, Fig. 1.)

The variations of this species seem confined to greater or less elevation of the spire and more or less acute apical angle of the same. The specimens I have seen are more uniform in their general appearance than those of either of the other species of this region. They are never smooth, though the granules differ in prominence.

**Bulimulus (Scutalus) Baileyi** Dall, n. s. (*B. Xantusi* var., Stearns non Binney.)

Cape St. Lucas, W. J. Fisher and G. Eisen; Ortiz, Mexico, Vernon Bailey; Guaymas, Mexico, E. Palmer. (Plate LXXI, Fig. 1.)

Shell when perfectly fresh with a delicate brownish epidermis, which is usually lost, beneath which the shell is brownish flesh color with irregular pale streaks in harmony with the incremental lines; the margin of the whorl in front of the suture is also often whitish; dead shells are waxen or pure white, often with a ferruginous discoloration; whorls five and a half, the nucleus with a central pit or dimple at the apex, the first two turns regularly ribbed with small, sharp, rather distant ribs, the wider interspaces of which are spirally striate; subsequent whorls with close, fine, sharp, somewhat irregular wrinkles, in harmony with the incremental lines, sparser on the last whorl and crossed by fine sharp close striae of variable strength, sometimes hardly visible, but in other specimens distinct and granulating the wrinkles; all intermediate grades are observable in comparing many specimens; suture distinct;

form like that of *pallidior* on a smaller scale, varying from moderately wide to slender; whorls rounded or moderately flattened; umbilicus small but deeper proportionately than in *pallidior*; aperture rounded ovate, the lip rather widely reflected, thin, the outer and pillar lips approximating, united by a thin wash of callus.

*Measurements of a slender and a stout specimen, respectively.*

	Milli- meters.	Milli- meters.
Altitude of shell.....	28.0	28.5
Altitude of last whorl.....	23.0	22.5
Altitude of aperture.....	15.0	16.0
Maximum breadth of aperture.....	11.5	12.0
Maximum breadth of shell.....	17.0	15.0

This species is larger than *B. Xantusi* and the latter is without a reflected lip. *B. Baileyi* has the color of *excelsus* rather than *pallidior*. Its variations, within the limits of its smaller size, are similar to those of *pallidior*; the granulation of the surface in the rougher specimens is much finer, but of the same character as that of *B. montezuma*. The species was at first confounded with *B. Xantusi*, the type of which had been mislaid, but when the latter was found and a series compared, it was obvious that they belonged to different sections of the genus. It is named in honor of Mr. Vernon Bailey, of the U. S. Department of Agriculture, who collected it in western Mexico.

Section DRYMÆUS Albers.

*Bulimulus (Drymæus) californicus* Reeve.

"California," Hartweg, fide Reeve; Gulf coast of Lower California, Stearns.

Only one specimen of this little-known species is in the national collection, and it unfortunately has had the pillar broken, apparently in removing the animal. It recalls *B. Liebmanni*, but is nearest to *B. serperastrus* Say, but is more slender than any specimen of *serperastrus* observed in our very large series from many localities. The peristome is reflected, especially in front, and the surface is polished.

Section MESEMBRINUS Albers.

*Bulimulus (Mesembrinus) Xantusi* W. G. Binney, not Cooper. (*B. Gabbii*, Crosse and Fischer.

Cape St. Lucas, Xantus (type); Rancho Lagunas, Punta Arena, near sea level, Bryant; Sierra Laguna, near La Chuperosa, altitude 2,000 feet, Eisen. (Plate LXXII, Fig. 4.)

The specimen from which Mr. Binney described the species, and which was figured to illustrate it, is in the National Collection (Mus. Reg. 9017) and must be regarded as the type. It is finely but intensely granular from the spiral striation, and agrees in every respect with the form described and figured by Crosse and Fischer in their fine work on the Mollusks of Mexico under the name of *B. Gabbii*. The lip is not

reflected in any of the specimens. The specimens collected by Bryant and Eisen are of the smooth, or rather not granulated variety *levis*, which accounts for Dr. Cooper's inability to harmonize them with Binney's description and figure. The epidermis is thin and olivaceous, and Dr. Cooper reports the most perfect specimen as being streaked with brown, lighter and darker, as on *B. alternatus*.

The type of *B. Xantusi* measures 20 mm. long, 10½ mm. in greatest width, the aperture 10 by 7 mm. The smooth ones are variable in size, measuring from 18 by 10.5 to 17 by 8.5 mm. None of the specimens received from Dr. Cooper show any trace of color markings. *B. digitale*, described by Reeve (Conch. Ic., Pl. 47, Fig. 308, November 1848) without habitat, bears from the figure a very close resemblance to *B. Xantusi*.

Section LEPTOBYRSUS Crosse and Fischer.

The type of this section is *B. spirifer* Gabb, but from a study of the species I am satisfied that several of the other species are too closely related to be separated from *B. spirifer* sectionally, though at first sight they fail to show the characters clearly. The section contains two sets of species, which are separated by the presence or absence of the prominent lobe or flange on the pillar in the first half of the last whorl, but all the species present occasional individuals which show a ridge here, even if the majority of the conspecific specimens do not. The nuclear whorls are peculiar, and agree closely, especially in the sunken position of the extreme nucleus making a pit or dimple on the apex of the spire; the nuclear whorls have a peculiar and when unworn a very sharp and characteristic sculpture, and most of the species have an extremely similar facies, the most aberrant form being *B. artemesia*, which, however, differs only by its more numerous whorls, slender form, and the less-reflected peristome. I am confident that all these species are genetically connected, and that they should be embraced in one sectional group.

Subsection A; without prominent lamella.

*Bulimulus (Leptobyrus) artemesia* W. G. Binney.

Cape St. Lucas, Xantus, 1 (type) specimen: Sierra Laguna, at 3,000 feet above the sea, 2 specimens, Eisen. (Plate LXXII, Fig. 5.)

The type is in good condition; it has eight and a half whorls, of which the first two are obtusely keeled above and the nuclear point small and sunken, forming an apical funicular pit which is quite conspicuous. The sculpture of the nucleus is like that of the other species already mentioned, of rather sparse fine, sharp riblets, with the wider interspaces more or less spirally engraved. The surface is wrinkled finely, with traces of granulation here and there on the wrinkles. The peristome is slightly reflected, and inside thickened in the manner characteristic of a shell which has passed the dry season adhering to the bark of a tree. The pillar far within the aperture shows a faint elevated ridge. Traces of epidermis on the shell are pale olivaceous

yellow, the shell itself of a waxen white. It appears to be a rare species, and the furthest removed from the others which constitute the section. Yet I cannot believe that it is less related to *inscendens* (for instance) than to *B. pupiformis*.

**Bulimulus (Leptobyrsus) inscendens** W. G. Binney.

Cape St. Lucas, Xantus (types); Lower California, 100 to 3,000 feet above the sea, San José del Cabo, San Leonicio, etc., Eisen (typical form): Sierra Laguna, altitude 3,000 feet (smooth variety), Eisen; San José del Cabo and Punta Arena, Lower Cal. (var. *Beldingi* Cooper) Belding and Bryant. (Plate LXXII, Fig. 6.)

The type specimens of this species show the very distinct granulation due to spiral striae, and have a nucleus like that of *B. artemesia*, obtusely keeled above. The pillar has a more or less distinct fold which, however, never becomes laminar, and is often feeble. The spiral striation may be coarse, fine, or absent, as in the species previously described. A smooth form—that is, one in which there is no spiral striation or granulation of the axially directed wrinkles, yet which has the form of the type, also occurs. Both this and the type have large shells with flattish whorls and a rather acutely conical spire. The other varieties are as follows:

Var. *alta* Dall; whorls rounder, shell shorter, last whorl 25–38, aperture 20–38 of the whole length. This form leads to var. *Beldingi*. Whorls  $7\frac{1}{2}$ , altitude 38; maximum diameter 14 mm. Var. *monticola* Dall; more slender, smooth, compact, last whorl 23–40, aperture 17–40 of the whole length. This recalls *B. Bryanti* Cooper, but is less slender, has not the divergent last whorl, nor the laminiferous pillar. Whorls  $7\frac{1}{2}$ , altitude 40, maximum diameter 14 mm. Var. *Beldingi*, Cooper; smaller, stouter, without spiral striation; last whorl 22–32, aperture 15–32 of the whole length. It is difficult, without a connecting series, to believe that this is not a distinct species from the typical *inscendens*. If they should be so divided hereafter, the above varieties *alta* and *monticola* would range with *Beldingi* rather than with *inscendens* proper. Whorls in the typical *Beldingi*  $6\frac{1}{2}$ , altitude 32, maximum diameter 14 mm. The reflection of the peristome is narrower and thicker than in most of this group.

**Bulimulus (Leptobyrsus) excelsus** Gould, (*B. elatus* Gld, olim.)

La Paz, Xantus, Belding, Fisher. (Plate LXXII, Fig. 7.)

This is the largest, finest, and most local of the forms of this group. When fresh is streaked with waxen-white and purplish-brown and is whitish in front of the suture. It has two nuclear whorls obtusely keeled and with a less conspicuous apical pit than the others. The spiral striae on the nucleus are often extremely faint, but can usually be made out with a magnifier on the later whorls. I have not seen any specimens where the striation was strong enough to granulate the wrinkles. While differing somewhat in form, the size is rather uniform

compared with that of the other species, as might be expected from its smaller range in area and altitude. The pillar bears an observable fold, but no lamina.

*Bulimulus (Leptobyrsus) Zeledoni* Dall, sp. nov.

Costa Rica, Zeledon, Mus. Reg. 98231. (Plate LXXI, Fig. 2.)

Shell thin, colorless, with translucent, polished, pale yellow epidermis and seven whorls; apical pit small, the nuclear whorls rounded, the riblets upon them close set and cut by equidistant spiral grooving, so as to produce a close, even reticulation like that of close-woven cloth; apex rather pointed, whorls slightly rounded, suture distinct; surface sculptured with obscure incremental wrinkles and very faint sparse spiral striae; last whorl more than half the length of the whole shell; base rounded, with a narrow umbilicus, over which the pillar lip is broadly reflected; aperture short, wide, peristome thin, reflected, except near the sutural commissure, the reflection becoming more marked in proportion as one passes from the suture forward, and widest of all at the pillar, which is straight, almost forming an angle with the lip at its base; body with a slight wash of callus; a slight fold at the back of the pillar, but no lamina. Longitude of shell 30, of last whorl 17, of aperture 11; maximum latitude of shell 13.5, of aperture 10 mm.

I have included this species, collected by Señor Don José Zeledon, because it does not seem to be described, and also because it seemed naturally associated with the species of Lower California, to which this article is devoted. It is easily recognized when perfect by its nuclear sculpture and simple coloration, polished epidermis, and rather wide squarish aperture.

Subsection B, with a prominent lamina projecting from the pillar in the first half of the last whorl.

This group at present comprises three species, and the internal features are essentially the same in each. About the time that the penultimate whorl is beginning to be formed the pillar becomes gyratory, so that, viewed from below, it describes a spiral curve around an imaginary cylindrical axis of greater or less diameter. After completing its round and beginning on the last whorl the outer edge of the gyre becomes thickened and expanded in a fin-like manner with thick rounded margin; the twist of the pillar becomes more nearly axial, and at the aperture of the shell shows merely as a fold or rounded ridge such as appears in the various species of subsection A.

*Bulimulus (Leptobyrsus) spirifer* Gabb.

"In the mountains, among rocks, from San Antonio below La Paz to near San Borja, and in the highest mountains, perhaps even farther north." Gabb. San José on the Gulf of California. Belding. (Plate LXXII, Fig. 8.)

Nearly all the specimens in the national collection were received from Gabb, so that they are authentic. The species has been confounded

with others by several writers, but is clearly a distinct and well characterized form, and is the type of *Leptobyrsus*, according to the authors of that name. The species is noticeable for the oily gloss of its surface. The lamina is usually visible with difficulty or not at all from the aperture; "the prominent tooth winding inward from the columella," mentioned by Dr. Cooper,\* is the fold on the pillar and not the lamina, which last he does not seem to have observed or differentiated.

The nucleus hardly differs from that of *inscendens*, the shoulder of it is rounded, not angular, and the spiral striae are faint. The color of the shell is more brownish and less livid than in *excelsus*, the pale streaks, though frequently present, are less conspicuous, and the whitish edge of the whorl in front of the suture is less constant. The shell is the thinnest of all the species. It varies in form much like the others.

**Bulimulus (Leptobyrsus) Bryanti** (Cooper) Dall. *B. inscendens Bryanti* Cp. op. cit., p. 101, Pl. XIII, figs. 4 a-c, 1893.

"On dry mountains, 800 to 1,000 feet high, climbing high copal trees, northward from Cape St. Lucas, through a distance of 350 miles." Xantus, San Jose del Cabo, Bryant. (Plate LXXI, Figs. 3, 4.)

Usually white, but when living or fresh, pale-brown, showing hardly any spiral sculpture. Nucleus as in the last species. Lamina extraordinarily thick and rounded, not visible from the aperture. Surface nearly smooth but not polished; reflection of the peristome narrow and feeble.

This was referred to *inscendens* as a variety, but appears to be nearest to *spirifer* and a well-defined species.

**Bulimulus (Leptobyrsus) Veseyianus** Dall, sp. nov.

Espiritu Santo Id., Gulf of California. Belding. (Plate LXXI, Figs. 4, 5.)

Shell stout, inflated, brownish, polished, with seven whorls; suture appressed, distinct, but shallow; nucleus worn in all the specimens but apparently not differing from that of *B. Bryanti* except as being more blunt; whorls except the last rather rounded, the last whorl somewhat flattened at the periphery; umbilicus large but narrow, overshadowed by a very wide expansion of the pillar-lip; aperture large, the lips approximated behind, the reflection wide and greatly recurved, of a livid waxen passing into white at the margin; body moderately callous, pillar straight with an obscure fold visible at the aperture, internally with a large thick sublinguiform lamina; surface of the shell like that of *B. excelsus*, but more polished. Lon. of shell, 36.5; of last whorl, 25; of aperture, including the lip, 20; maximum diameter of shell, 20; of aperture, 15 mm.

This species is named in honor of Mr. J. Xantus de Vesey, to whom we owe much of our knowledge of the fauna of Lower California. It is recognizable by its short, stout shape, widely reflected recurved peristome, very narrow space between the commissures of the lips and body, and large subtriangular lamina. Five specimens, all very uniform, were collected by Mr. Belding (Mus. Reg., 34122) some ten years ago.

\*Proc. Cal. Acad. Sci., 2nd series, Vol. iii, p. 211, 1892.

Section ORTHOTOMIUM. Crosse and Fischer.

**Bulimulus (Orthotomium) sufflatus** Gould. (*B. vesicalis* Gld. olim.)

Lower California, Rich; low lands about La Paz, Gabb; San José del Cabo to La Paz, Bryant. Sierra Laguna to 3,000 feet above the sea, Eisen. Variety *insularis* Cooper, Espiritu Santo Island, Bryant. Abundant near La Paz, Belding. (Plate LXXII, Fig. 9.)

This characteristic shell has no coloration except in its epidermis, which is straw color or pale olive, intensified at lines which represent resting stages, and more or less polished. The form varies from 33.5 by 17, and 36.5 by 21 to 32 by 23 mm. The peristome is slightly reflected in front and widely over the umbilicus; elsewhere it is not reflected. In specimens which have survived a dry season attached to bark or a stone, the inside of the peristome and the space on the body between the two lips is often much thickened by a deposit of callus. The nucleus is similar to that of *Leptobysus*, except that the apical part is irregularly punctate, and the riblets instead of being even and sharply defined are more or less wavy and on the shoulder and earlier part give a vermicular effect. The apical pit is not conspicuous though evident in some examples. Pathologic specimens showing lumps or tubercles on the pillar are not very rare, but normally the pillar is simple. The young are frequently taken for *B. pilula* from which they may be discriminated by their projecting and more sharply sculptured nuclear whorls and less open umbilicus as well as more ovate form.

**Bulimulus (Orthotomium ?) pilula** W. G. Binney.

Cape St. Lucas to Margarita Island, Xantus. San José del Cabo, Bryant. The specimens collected at Punta Arena by Bryant and mentioned by Dr. Cooper are probably immature *sufflatus*. (Plate LXXII, Fig. 10.)

The types of this species in the National Museum have a distinct and mature appearance. The specimens connecting them with *sufflatus* are usually young *sufflatus*. The two types have 4 and 4½ whorls, respectively, as many as specimens of *sufflatus* four times their size. The nuclear whorls are smaller than in *sufflatus* and more delicately sculptured, while the incremental wrinkling on the body whorl is more conspicuous and regular than in the larger species. I have seen no specimens of *pilula* which appear to be genuine except the types. All the others when critically studied resolve themselves into varieties of *sufflatus*.

U. S. NATIONAL MUSEUM, June, 1893.

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